CHAPTER IX

CHEMICAL STORAGE, HANDLING, AND APPLICATION

A. BASIC CONSIDERATIONS

1. PLANS AND SPECIFICATIONS - These documents shall be submitted to KDHE for review and approval:

   a. Descriptions of feed equipment, including maximum and minimum feed ranges and accuracy.

   b. Location of feeders, piping layout, and points of applications.

   c. Storage and handling facilities.

   d. Specifications for chemicals to be used.

   e. Operating and control procedures including proposed application rates.

   f. Descriptions of testing equipment and procedures.

   g. No chemicals shall be applied to treat drinking waters unless specifically approved by KDHE.

2. APPLICATION POINTS - Chemicals should be applied to the water at such points and by such means as to:

   a. Provide a high degree of safety to the consumer and operator of a PWSS.

   b. Provide adequate flexibility of operation through various points of application, when appropriate.

   c. Prevent backflow or back-siphonage between multiple points of feed through a common manifold.

   d. Prevent clogging, deterioration, or malfunctioning of valves, sluice gates, or other equipment, e.g., do not add lime just upstream from a sluice gate.

   e. Facilitate cleaning, maintenance, and proper mixing of chemicals and water.

3. FEED EQUIPMENT

   a. NUMBER OF FEEDERS

      1) A separate feeder shall be used for each chemical applied except where the feeder can be used for other chemicals after appropriate cleaning and adjustments.

2) Where chemical feed is required for the protection of the PWSS, e.g., for disinfection, coagulation, or other essential processes, standby feeding machines are required.

3) The standby unit or a combination of units of sufficient capacity should be available to replace the largest unit during shut-downs.

4) Spare parts should be available for all feeders to replace those which are subject to wear and damage.

b. DESIGN AND CAPACITY

1) Feeders should be able to supply at all times the necessary amounts of chemicals at an accurate rate (+/- 5 percent) throughout the normal feed ranges.

2) Chemical feeders should be adjustable so that the chemicals can be added in proportion to flow or the amount of contaminant in the untreated water. Provisions should be made for measuring the quantities of chemicals used.

3) Weighing Scales

a) Shall be provided for weighing cylinders at all plants utilizing chlorine gas.

b) Should be provided for fluoride solution containers.

c) Shall accurately measure increments of one percent of the maximum load of the scale.

4) Positive displacement type solution feed pumps should generally be used to feed liquid chemicals. However, centrifugal pumps are approved for delivering coagulants. Pumps requiring check valves should not be used to pump slurries. Pumps must be sized to match or exceed maximum head conditions found at the point of injection.

5) The service supply water shall be protected from possible contamination by chemical solutions using either of the following:

   a) Equipping the supply and feed lines with backflow or backsiphonage prevention devices.

   b) Providing an air gap between the supply line and the solution tank.

6) Contact materials and surfaces shall be resistant to the aggressive nature of the chemical solutions.

7) Dry chemical feeders with solution tanks should be designed to provide adequate solution water and agitation of the chemical in the solution pot, and to provide for gravity feed.

8) Completely enclose chemical bins or dry tanks to minimize dust releases to the operating room. All bins should be equipped with dust collector bags.

9) No direct connection shall exist between any sewer and a drain or overflow from the feeder or solution chamber or tank by providing that all drains terminate at least 6 in (15 cm) or two pipe diameters, whichever is greater, above the overflow rim of a receiving sump, conduit, or waste receptacle.

c. LOCATION - Chemical feed equipment should:

1) Be located reasonably close to the point of application.

2) Be readily accessible for servicing, repair, and observation or operation.

3) Be located in a separate room to reduce hazards and dust problems, and provided with protective curbing so that chemical from equipment failure, spillage, or accidental drainage will not enter the water in conduits, treatment, or storage basins.

d. FEEDER LINES - Chemical feed lines should be:

1) Such that each chemical is carried in a separate line.

2) Exposed, and lines encased in concrete floors or walks, should be avoided. Lime slurry should be carried in an open flume where possible, and these lines should be readily accessible to permit their inspection by operators.

3) Reasonably short in length; be of durable, corrosion resistant material; be easily accessible throughout entire length; be protected against freezing; and readily cleanable.

4) Sloped upward from the chemical source to the feeder when conveying gases.

5) Designed to minimize the corrosive potential of chemicals, e.g., through the use of sample dilution water and diffuser systems.

6) Designed to avoid scale formation or solids deposition by the water, chemical, solution, or mixture conveyed.

7) Color coded (see Table 2 in Chapter III, General Facilities Considerations).

e. CONTROLS

1) Feeders may be manually or automatically controlled, but automatic controls must be capable of manual operation when necessary.

2) Automatic chemical dose or residual analyzers are desirable and should provide alarms for critical valves, and recording charts, or a digital readout with a computerized data logger.

3) At automatically operated facilities, chemical feeders shall be electrically connected with the pumps providing the flow.

f. SOLUTION TANKS

1) The solution tank shall be constructed or lined with a material that is compatible with the chemical solutions to be stored in it and certified by the tank supplier for this use.

2) Means should be provided in a solution tank to maintain a uniform strength of solution consistent with the nature of the chemical solution. Continuous agitation is necessary to maintain slurries in suspension.

3) Two solution tanks of adequate volume may be required to assure the continuity of a chemical supply during the servicing of a solution tank.

4) Each tank should be provided with a drain.

   a) Any drain should terminate at least two pipe diameters above the overflow rim of a receiving sump, conduit, or waste receptacle.

   b) In no case should drains discharge directly into sewers, streams, or water treatment flow. Preferably these discharges should drain to a sump from which they can be disposed of safely.

5) Means should be provided to indicate the level in the solution tank.

6) Chemical solutions should be kept covered. Large tanks with access openings should have such openings curbed and fitted with overhanging covers.

7) Subsurface locations for solution tanks are not approved.

8) Overflow pipes, when provided, should be turned downward with their ends screened, have free discharges, and be located where noticeable.

g. DAY TANKS

1) Day tanks shall be provided where bulk storage of liquid chemical is provided.

2) Day tanks shall meet all the requirements for solution tanks.

3) Day tanks should hold no more than a 30 hour supply or the volume required for one shift's operation.

4) Day tanks shall be scale-mounted, or have a calibrated gauge painted or mounted on the side if liquid level can be observed in a gage tube or through translucent sidewalls of the tank. In opaque tanks, a gage rod extending above a reference point at the top of the tank, attached to a float may be used. The ratio of the area of the tank to its height must be such that unit readings are meaningful in relation to the total amount of chemical fed during the day.

5) Hand pumps may be provided for transfer from a carboy or drum. A tip rack may be used to permit withdrawal into a bucket from a spigot. Where motor-driven transfer pumps are provided, a liquid level limit switch and an overflow from the day tank, must be provided.

6) A means which is consistent with the nature of the chemical solution shall be provided to maintain uniform strength of solution in a day tank. Continuous agitation shall be provided to maintain chemical slurries in suspension.

7) Tanks shall be properly labeled to designate the chemical contained.

h. SERVICE SUPPLY WATER

1) Water used for dissolving dry chemicals, diluting liquid chemicals, or operating chemical feeders shall be:

a) Only from a safe, approved source.

b) Protected from contamination by appropriate means.

c) Ample in quantity and adequate in pressure.

d) Provided with means for measurement when preparing specific solution concentrations by dilution or for use in determining chemical feed rates.

e) Properly treated for hardness when necessary.

f) Obtained from a location sufficiently downstream of any chemical feed point to assure adequate mixing.

2) Where a booster pump is required, duplicate equipment should be provided, and when necessary, standby power.

3) Backflow prevention should be achieved by appropriate means such as:

a) An air gap between the fill pipe and the maximum flow line of the solution or dissolving tank at least two pipe diameters, but not less than 1 in (2.5 cm).

b) An approved reduced pressure zone backflow preventer, consistent with the degree of hazard, aggressiveness of chemical solution, and available means for maintaining and testing the device.

c) Depending on the specific application, other backflow prevention assemblies or devices may be approved consistent with the KDHE requirements for cross connection programs.

4. CHEMICALS

a. Quality

1) Chemicals shall meet applicable AWWA Standards (4) and NSF Standard 60 - Drinking Water Treatment Chemicals (28).

2) Provisions may be required for assay of chemicals delivered.

3) Chemicals having a distinguishing color may be used, providing the coloring material is not toxic in the concentrations used and will not impart T&Os or color to the treated water supply.

b. SHIPPING CONTAINERS - Chemical shipping containers shall be fully labeled to include:

1) Chemical name, purity, and concentration.

2) Supplier name and address.

c. PROTECTIVE MEASURES - Recommended safety requirements and protective measures for handling of all chemicals utilized by a PWSS should be determined and recorded in a safety procedures manual. Sources of information about a particular chemical include the Material Safety Data Sheet, product label, chemical manufacturer, trade associations such as the Chlorine Institute, and information compiled by regulatory agencies. These safety procedures should be reviewed regularly with all personnel. New employees, who may be exposed to a chemical in handling or storage, should be thoroughly instructed in the PWSS's safety requirements and protective measures for the chemical.

d. STORAGE

1) Space should be provided for:

a) At least 30 days of chemical supply based on the average flow and dosage conditions; however, space needs should be adjusted to account for delivery time and needs for maximum process conditions.

b) Convenient and efficient handling with dry storage conditions.

2) Storage tanks and pipe lines for liquid chemicals shall be specific to the chemicals unless the facilities are completely purged or cleaned before an alternate chemical is used.

3) Liquid chemical storage tanks should have a liquid level indicator, and an overflow and a receiving basin capable of holding 110 percent of the stored volume, or drain capable of receiving accidental spills or overflows. Hazardous materials may require extra precautions.

4) Special precautions should be taken with materials requiring isolated, fireproof storage; explosion-proof electrical outlets, lights, and motors in the chemical handling areas.

5) Chemicals should be stored in covered or unopened shipping containers, unless the chemical is transferred into an approved covered storage unit.

6) Acid storage tanks should be vented to the outside atmosphere, but not through vents in common with day tanks.

e. HANDLING

1) Piping materials for transport of chemicals must be corrosion resistant at working temperatures and pressures.

2) Chemicals that are incompatible should not be fed, stored, or handled together.

3) Provision should be made for the proper transfer of dry chemicals from shipping containers to storage bins or hoppers, in such a way as to minimize the quantity of dust which may enter the room in which the equipment is installed. Control should be provided by use of:

a) Vacuum pneumatic equipment or closed conveyer systems.

b) Facilities for emptying shipping containers in special enclosures.

c) Dust filters and exhaust fans which put the hoppers or bins under negative pressure.

4) Carts, elevators, and other appropriate means should be provided for lifting and moving chemical containers to minimize handling by operators.

5) Provisions should be made for disposing of empty bags, drums, or barrels, either by burning or by some other approved procedure which will minimize exposure to dusts.

6) Provision should be made for proper transfer of dry chemicals from storage to the chemical feed device, in such a way as to minimize the quantity of dust which may enter the room. Gravity and conveyer systems should be dust tight and adequate ventilation provided.

7) Vibrators should be installed on bulk storage tanks to prevent bridging of stored materials.

f. HOUSING

1) Structures, rooms, and areas accommodating chemical feed equipment should provide convenient access for servicing, repair, and observation of operation.

2) Floor surfaces should be smooth and impervious, slip-proof, and well-drained with 2 in (5 cm) per 10 ft (3.0 m) minimum slope.

3) Open basins, tanks, and conduits should be protected from chemical spills or accidental drainage.

4) Pipes and feed lines through interior walls should be sealed with non-shrink grout or some other positive means.

5) Vents from feeders, storage facilities, and equipment exhaust shall discharge to appropriate pollution control devices before release to the atmosphere above grade and remote from air intakes.

g. OPERATOR SAFETY

1) Open basins, tanks, and conduits should be protected from chemical spills or accidental drainage.

2) At least one pair of rubber gloves, a dust respirator of a type approved by OSHA for toxic dusts, and an apron or other protective clothing should be provided for each operator on any shift who will handle dry chemicals. A deluge shower and/or eyewashing device should be installed where strong acids and alkalis are used or stored.

3) A water holding tank that will allow water to come to room temperature must be installed in the water line feeding the deluge shower and eyewashing device. Other methods of water tempering will be considered on an individual basis.

4) Facilities should be provided for washing of an operator's person, apparel and protective equipment.

5) Other protective equipment shall be provided as necessary.

h. HAZARDOUS MATERIAL HANDLING AND SPILLS

Safety provisions in handling hazardous materials and reporting spills or hazardous materials should be in accordance with KDHE and local standards.

B. CHLORINE GAS REQUIREMENTS

Gas chlorination requirements (excluding chlorine dioxide) shall conform to those specified by the Chlorine Institute (42).

1. CHLORINATOR SPECIFICATIONS

a. For gas withdrawal systems, only solution-feed, vacuum-operated chlorinators shall be utilized in which chlorine gas is maintained under vacuum throughout the apparatus. Such systems typically employ a chlorine gas ejector which creates a partial vacuum into which chlorine gas is drawn from the cylinder and injected into the supply water to form a concentrated chlorine solution. The concentrated chlorine solution is conveyed through a corrosion-resistant conduit for application to the water being treated. Direct-feed chlorinators which deliver liquid or gaseous chlorine under positive pressure directly to the point of application will not be approved.

Other essential features of a solution-feed, vacuum-operated chlorinator include the following:

1) A flow regulating system which will automatically shut off chlorine feed upon loss of vacuum due to such causes as vacuum leak, stoppage in the chlorine solution discharge line, plugging of the ejector, or loss of pressure in the water supply line.

2) A chlorine feed rate indicator, appropriately sized for the desired feeding range.

3) A means for setting or controlling the rate of chlorine such as a regulating diaphragm assembly. Automatic proportioning feed rate controls shall be provided where the rate of flow or chlorine demand is not reasonably constant. The equipment shall be of such a design that it will operate accurately over the desired feeding range.

4) A check valve or other flow interlock device to prevent the backflow of water into the chlorinator.

5) A means to vent gas to the outside in the event that the chlorine feed regulating system should leak during shutdown.

6) Gauges for measuring water pressure in the water supply line to the ejector and in the chlorine solution line at the outlet of the ejector. Further, a vacuum gauge should be provided in the vacuum line between the ejector and the chlorinator.

b. Filters and traps ahead of chlorinator control apparatus are desirable to prevent impurities inherent in chlorine from reaching the chlorinator control mechanisms.

c. Each chlorine gas ejector must be selected for the point of application with particular attention given to the quantity of chlorine to be added, the maximum ejector water flow, the total discharge back pressure, the required ejector operating pressure for creation of vacuum, and the size of the chlorine solution lines. In order to establish sufficient ejector operating pressure, a booster

pump may need to be provided in the water supply line. The water supply to each ejector shall have a separate shut-off valve. No master shut-off valve will be allowed.

d. The concentrated chlorine solution should be applied to the water being treated so as to provide a rapid and thorough mix. The center of a pipeline is the preferred application point.

e. Disinfection apparatus should be in duplicate, or provided with sufficient spare parts to insure no interruption in the delivery of properly disinfected water.

2. CHLORINE CONTAINERS

a. Chlorine cylinders and containers should be fabricated to DOT and Chlorine Institute specifications (42).

b. All containers should be equipped with at least one pressure (or safety) relief device.

c. Full and empty cylinders of chlorine gas shall be:

1) Isolated from operating areas.

2) Adequately secured in a vertical, upright position by means of chains or other devices.

3) Stored in rooms separate from ammonia storage.

4) Stored in areas not in direct sunlight or exposed to excessive heat.

5) For the safe handling of ton (900 kg) containers, a lift clamp of the type recommended by the Chlorine Institute must be used in combination with a hoist or crane having a capacity of at least 2 tons (1,800 kg). Ton containers must be stored so that they will not receive direct sunlight or be contacted by rain or snow. Pairs of level rails or properly designed cradles should be provided for storing one ton cylinders.

6) Scales must be provided to determine the amount of chlorine applied to the water as indicated by the loss in weight in the chlorine cylinders or containers.

3. CHLORINATOR PIPING

a) Cross-Connection Protection - the chlorinator water supply piping shall be designed to prevent contamination of the treated water supply by sources of questionable quality.

b) Liquid or dry gaseous chlorine - The pipes carrying elemental liquid or dry gaseous chlorine under pressure must be Schedule 80 seamless steel tubing or other materials recommended by the Chlorine Institute (never use PVC) (42). Piping arrangements should be as short and simple as possible, preferably above ground. The number of joints should be held to a minimum. Piping systems should be well supported and adequately sloped to allow drainage. Low spots should be avoided.

c) Direct-cylinder mounted gas chlorinators are recommended where manifolding of two or more cylinders is not necessary. This avoids the utilization of flexible connectors or other connecting pipe between the cylinder and the gas chlorinator. Gaseous chlorine will tend to reliquify upon a decrease in the temperature of the connecting line relative to the gas cylinder. Reliquefaction of chlorine within the connecting line may result in liquid chlorine reaching the chlorinator or lead to premature failure in the line, itself. If a connecting line between the cylinder and the chlorinator must be utilized, reliquefaction may be prevented by installation of an external chlorine pressure reducing valve close to the cylinder or insulating the line.

d) All piping carrying chlorine gas or chlorine solution, should be color coded as specified in Table 2 of Chapter III, General Facilities Considerations.

e) Chlorine solution - Rubber, PVC, polyethylene, or other materials recommended by the Chlorine Institute must be used for chlorine solution piping and fittings. Nylon products are not acceptable for any part of the chlorine solution piping system.

f) Thermal expansion - Suitable allowance should be made for pipe expansion due to changes in temperature. This is particularly true in the transport of liquid chlorine which has a high coefficient of thermal expansion. High pressures can develop upon an increase in the temperature of the chlorine. This could result in hydrostatic rupture of the line. The effects of possible rupture must be considered in the design of any piping system.

g) Pressurized chlorine feed lines shall not carry chlorine gas beyond the chlorinator room.

h) Automatic switch over of chlorine cylinders or containers should be provided, where necessary, to assure continuous disinfection.

i) The chlorine gas discharge rate should not exceed 1.75 lbs/hr (0.79 kg/hr) from either a single 100 or 150 lb (900 or 1,350 kg) chlorine cylinder, or 15 lbs/hr (6.8 kg/hr) from a single ton (980 kg) container. The assumptions underling these permissible discharge rates include an ambient temperature around the cylinder or container of 70°F (21°C), natural air circulation, and that the gauge pressure against which the cylinder or container is discharging is approximately 35 psi (241 kPa). Higher withdrawal rates can be achieved through either the manifolding of multiple cylinders or containers, or the installation of an evaporator which allows liquid chlorine withdrawal.

4. TESTING EQUIPMENT - Chlorine residual test equipment recognized in the latest edition of *Standard Methods* (13) shall be provided, and should be capable of measuring residuals to the nearest 0.1 mg/L in the range below 0.5 mg/L, to the nearest 0.3 mg/L between 0.5 and 1.0 mg/l, and to the nearest 0.5 mg/L between 1.0 and 2.0 mg/L. Automatic chlorine residual recorders should be provided where the chlorine demand varies appreciably over a short period of time. All treatment plants having a capacity of at least 6 mgd (19,000 m^3/day) or serving a population greater than 3,300 persons should be equipped with recording chlorine analyzers monitoring water entering the distribution system.

5. RESPIRATORY PROTECTION EQUIPMENT - Respiratory protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) shall be available where chlorine gas is handled, and shall be stored outside every room where chlorine is used or stored. Respiratory protection equipment may consist of either an air purifying respirator (canister gas mask type) designed for chlorine gas or an air supplied respirator such as a self-contained breathing apparatus.

Air supplied respirators are recommended over air purifying respirators for the following reasons. Air purifying respirators do not compensate for a lack of oxygen. A minimum of 19.5 percent oxygen must be present before such respirators are used. They are also subject to manufacturer's use limitations for the particular contaminant. Though most chlorine releases are at low concentrations and canister gas masks would offer adequate protection, without the installation of chlorine monitoring equipment for sampling air in the vicinity of the leak, it is not possible to confirm the safety of the canister gas mask in each situation.

6. CHLORINE GAS FEED AND STORAGE ROOM SPECIFICATIONS -

a. Chlorine gas feed and storage shall be enclosed and separated from other operating areas. Each such room shall be:

1) Provided with a shatter resistant, gas-tight, inspection window installed in a door or interior wall of the chlorine room to permit the chlorinator(s) to be viewed without entering the room.

2) Constructed in such a manner that all openings between the chlorine room and the remainder of the plant are sealed.

3) Provided with doors equipped with panic hardware, assuring ready means of exit and opening outward only to the building exterior.

4) Provided with sufficient space for a scale and storage of at least one spare cylinder or container for each one connected in service.

5) Posted with appropriate warning signs as required by the emergency preparedness agency or local fire department having jurisdiction over the facility.

b. Where chlorine gas is used, the room shall be reasonably gas tight and constructed to provide the following:

1) Each room shall have a ventilating fan with a capacity of one complete air change per minute when the room is occupied.

2) The ventilating fan shall take suction near the floor as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air inlets to any rooms or structure.

3) Air inlets should be through louvers near the ceiling.

4) Louvers for chlorine room air intake and exhaust shall facilitate airtight closure.

5) Separate switches for the fan and lights shall be located outside of the chlorine room and at the inspection window. Outside switches shall be protected from vandalism. A single light indicating fan operation shall be provided at each entrance where the fan can be controlled from more than one point.

6) Vents from feeders and storage shall discharge to the outside atmosphere, above ground.

7) The room location should be on the prevailing downwind side of the building away from entrances, windows, louvers, walkways, etc.

8) Floor drains are discouraged. Where provided, the floor drains shall discharge to the outside of the building and shall not be connected to other internal or external drainage system.

c. Chlorinator rooms should be heated to 60°F (15.6°C), and be protected from excessive heat. Cylinders and gas lines should be protected from temperatures above that of the feed equipment.

C. OTHER CHEMICALS

1. HYPOCHLORITES

a. STABILITY - There are many factors that affect the stability of hypochlorite solutions in storage such as the initial concentration, pH, temperature, and exposure to light sources. In particular, the temperature at which hypochlorite solutions are stored greatly influences the solutions' stability. Solutions must be protected from heat sources as higher temperatures increase the decomposition rate. Even under ideal storage conditions, however, decomposition of hypochlorite solutions cannot be avoided and will continue until the batch is totally decomposed. For example, utilizing decomposition rate equations developed by the Chlorine Institute, a 15-percent available chlorine sodium hypochlorite solution is estimated to decompose to 7.5-percent available chlorine in 136 days in storage at a temperature of 65°F (18.3°C) (43).

b. CONTAINERS - Sodium hypochlorite solution is often shipped in 5 and 55 gallon (18.9 and 208 L) drums and stored in the drums prior to use. The drums must meet DOT specifications and are generally manufactured of polyethylene. Sodium hypochlorite solutions of 7 percent by weight or greater must be stored in vented containers. If the venting rate is exceeded by the decomposition rate, swelling of the container may be apparent. Care must be taken when opening containers containing sodium hypochlorite solutions to detect and properly release excess pressure.

c. MATERIALS - As a general rule, no metals should be allowed to come in contact with sodium hypochlorite solution. Mild steel, stainless steel, and virtually all common metals will corrode rapidly on contact with sodium hypochlorite solutions. Where piping is necessary, Schedule 80 PVC is generally used.

d. DANGEROUS REACTIONS - Hypochlorites should never be mixed with acids, ammonia solutions, or solids containing ammonia salts. Hazardous gases may be formed. Further, hypochlorites may react violently with many organic compounds including greases, oils, fuels, etc.

e. PERSONAL PROTECTION - When handling calcium or sodium hypochlorite, it must never be allowed to contact the eyes. Hypochlorites can cause serious burns on the skin and damage the lungs. When handling these materials, the operator should wear a protective apron, rubber gloves, eye protection, and respiratory equipment.

2. ACIDS AND CAUSTICS

a. Acids and caustics shall be kept in closed, corrosion-resistant, shipping containers or storage units.

b. Acids and caustics shall be not be handled in open vessels, but should be pumped in undiluted form from original containers through suitable hoses, to the point of treatment or to a covered day tank.

3. SODIUM CHLORITE FOR CHLORINE DIOXIDE GENERATION - All chlorine dioxide is generated on-site because of it's explosive properties when stored. It is continuously generated using sodium chlorite with aqueous or gaseous chlorine. Several variations of these basic methods are available commercially. Proposals for the storage and use of sodium chlorite must be approved by KDHE prior to the preparation of final P&S. Provisions shall be made for proper storage and handling of sodium chlorite to eliminate any danger of explosion.

a. STORAGE

1) Sodium chlorite shall be stored by itself in a separate room and preferably stored in an outside building detached from the water treatment facility. It must be stored away from organic materials which would react violently with it.

2) The storage structure shall be constructed of noncombustible materials.

3) If the storage structure must be located in an area where a fire may occur, water sprinklers must be available to keep the sodium chlorite area cool enough to prevent decomposition from heat and the resultant explosive conditions.

b. HANDLING

1) Care should be taken to prevent spillage.

2) An emergency plan of operation should be available for the clean up of any spillage. Sprinklers shall be provided in housed handling facilities.

3) Storage drums must be thoroughly flushed prior to recycling or disposal.

c. FEEDERS

1) Positive displacement feeders shall be provided for sodium chlorite, sodium hypochlorite, or acid feed.

2) Tubing for conveying sodium chlorite or chlorine dioxide solutions shall be Type 1 PVC, polyethylene, or materials recommended by the manufacturer.

3) Chemical feeders may be installed in chlorine rooms if sufficient space is provided or facilities meeting the requirements of chlorine gas shall be provided.

4) Feed lines shall be installed in a manner to prevent formation of gas pockets, and shall terminate at a point of positive pressure.

5) Check valves shall be provided to prevent the backflow of chlorine into the sodium chlorite line.

4. OZONE

a. Ozone must be generated continuously onsite because it is unstable; however, it does not have the explosive potential of stored chlorine dioxide. Ozone must be generated from corona discharge equipment or other processes specifically approved by KDHE. Ozone concentrations should be a minimum of one percent by weight in air or oxygen.

b. Ozone is very corrosive and the only acceptable materials for use with ozone are 316 stainless steel, glass, Hypalon, Teflon, and concrete.

c. The ozonation disinfection process consists of two steps: 1) the dissolution of the ozone and, 2) contact to achieve disinfection. The former step requires mixing and the later is optimized using a plug flow regime. Each is necessary for optimum process conditions.

d. An off-gas disposal and/or destruction system must be used with the ozone conductor because some of the ozone will be in the gas phase and will exceed OSHA standards for ambient air. Several methods are available for controlling this discharge including reinjection of the ozone, heating to cause autodecomposition, chemical reduction with or without a catalyst, and dilution.

5. Anhydrous Ammonia - Unconfined liquid ammonia rapidly vaporizes to a gas with an intensely irritating odor.

6. Lime Slurry - Lime slurries must be stabilized to prevent the precipitation of dissolved solids which can foul downstream equipment prior to the point of application.

7. Powdered Activated Carbon - PAC shall be handled as a potentially combustible material. It should be stored in a building or compartment as nearly fireproof as possible. Other chemicals should not be stored in the same place. PAC is not normally explosive, however, it is combustible and will burn when ignited. PAC should not be stored where it can come in contact with gasoline, mineral or vegetable oils. Also, PAC should never be mixed or stored with disinfecting or oxidizing agents. PAC can be stored as a slurry up to one year without affecting its adsorptive capacity.

8. Polyphosphates - Polyphosphate solutions should be disinfected.

9. Polymers - Polymer tanks may require protective paint or plastic liners.

10. Quicklime and Soda Ash - Both chemicals are hygroscopic and can be difficult to handle after several months in bulk storage.